Mr. Steve Musolino
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April 2, 1999

Re: Opinion for OSHA Compliance of ODH Matter at RHIC Project, BNL

Mr. Musolino:

At your request, Hayes Environmental Services Inc. was commissioned to evaluate the RHIC project ODH conditions for compliance with current OSHA standards. The main thrust of your request was directed at how the RHIC project would meet OSHA's requirements regarding 19.5% oxygen deficiency limit (ODL) with ODH sensors set at 18%.

Documents were provided by your office identifying the project, test results, facility identifiers and concerns. Documents reviewed included:

1. Chapters 3 and 4 of the RHIC Safety Assessment Document with Appendices 5, 6 and 7.

2. Oxygen Deficiency Hazards (ODH), RHIC Project identified as SEAPPM NO. 2.2.4.1

3. OSHA Standards 29 CFR 1910.146 Permit Required Confined Spaces

4. Various NIOSH Criteria Documents

A visit was made to the RHIC Project and the Collider area was examined with special emphasis on a visual examination of ODH sensor placement, mechanical ventilation systems, makeup air and evacuation system capabilities. Additionally, the Cryogenic Control Room and attached Refrigeration Building were visited to understand how the system functioned.

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Facts:

The RHIC Industrial Hygiene Group expressed concerns with the ability of the RHIC to maintain compliance with OSHA standards related to oxygen deficiencies. Their concern addressed set points for the ODH sensors at 18% when operating the Collider System at the 50 k mode.

This concern is based upon scenarios with various potential releases of He into the structure surrounding the collider. It is important to note that the Collider protective structure does not meet OSHA's criteria for confined spaces.[1]

The Collider structure and attached 25 kW helium Refrigerator Building are equipped with ODH sensors installed at strategic positions to detect oxygen displacement by He. Generally the sensors are placed in areas where He is likely to accumulate in case leaks occur.

It should be noted that the Refrigerator Building 1005R, was determined to be a different class of work location and corresponding hazard class due to the number of piping, valving and cold box systems in the structure and the limited ventilation capacities of the exhaust fans. Therefore, workers in the 1005R building are specially trained and equipped to address a catastrophic failure in this building. For those reasons further compliance analysis by this writer was not conducted.

The Collider piping and beam tubes are constructed according to ANSI B31.1, Power Piping requirements and the vessels are built according to the ASME Pressure Vessel Code, Section VIII. Both standards are commonly used in most chemical and petrochemical processing facilities for building high pressure piping and vessel systems.

Overall, the ODH sensors for the Collider structure are placed at ceiling height throughout the facility. Understandably, the sensors are placed at the location where He is likely to accumulate due to He density properties.

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[1] **Definition from 29 CFR 1910.146: "Confined space" means a space that:**
(1) Is large enough and so configured that an employee can bodily enter and perform assigned work; and
(2) Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.); and
(3) Is not designed for continuous employee occupancy.

Studies of sampling results conducted at BNL and at FNAL show extremely high dispersion and good mixing rates of He under various leak test models. Further release modeling is to be conducted at BNL during the first week of April 1999 and is not a part of opinions expressed in this report.

Lastly, but most importantly, the entire cryogenic containment system (pipes, valves beam tubes, etc.) is monitored by the Cryogenic Computer Control Room manned 24 hours a day while the system is operating. As explained during my visit, a primary purpose of this system is to control the loss of He through leaks and other anomalies. The system is designed to monitor cryogenic losses and respond to those losses by means of system shut down, mechanical ventilation activation and other measures.

Opinion:

OSHA requires atmospheric levels of breathing air in confined spaces to be at least 19.5% on the low end and no higher than 23.5% on the high end. It is generally accepted that the standards are silent regarding oxygen content in any other setting such as levels in ambient air for other work environments.

The RHIC is not a confined space and therefore those standards do not apply here. It is anticipated that Collider spaces are normally occupied at various times during experiments, unlimited egress points into and out of the area and atmospheric conditions can easily be controlled by mechanical ventilation. Further, short of a total catastrophic failure of the He containment and piping system, the setting of the ODH sensors to a value less than 19.5 do not affect conditions in the Collider structure and therefore OSHA standards do not come into play.

The OSHA standards address atmospheric ODH exposures under "normal, foreseeable and actual operations." Catastrophic failures are not included in risks associated with the establishment of standards as related to piping and containment systems. Analogous to the RHIC systems is a gas producer or petrochemical refinery. The protective systems in those industries are not intended to protect workers from total failure.

With ODH sensors set at 18 % and according to current literature regarding ODH conditions, there is ample time to escape from the area to a safe location except for catastrophic failures. As previously discussed, the loss of cryogenic He will be identified in the Cryogenic Control Room long before

ODH sensors react and well before an IDLH condition manifests. In fact, the detection system in the control room may provide more of a safety factor for workers in the Collider structure than the ODH sensors, in that a response may be quicker.

Except for a catastrophic failure in the Collider Ring structure with workers at the point of failure, sample results failed to identify a condition that would result in any IDLH condition or that a hazardous atmosphere will develop. A greater hazard during a catastrophic failure would be the cold and noise associated with a significant loss of He.

Conclusions:

Generally, I would not concur with setting any type of atmospheric sampling device to a level lower than that required by OSHA standards or by the manufacturer. However, it is my opinion in this instance that setting ODH sensors in the Collider structure at 18% will not affect safety and health conditions in the RHIC facility at BNL. Further, it is my opinion that the RHIC facility at BNL exceeds OSHA standards for compliance with existing standards and work practices for similar type facilities.

My opinion is based upon the following:

1. Short of total catastrophic system failure there is no evidence of potential exposure to employees showing a hazard that could produce an oxygen deficient atmosphere.

2. Historical data gleaned from testing done in the facility.

3. Adequate mechanical ventilation systems in place.

4. PASS system monitoring and system loss detection of He.

5. Ample warning systems for evacuation from readily accessible exits even in case of catastrophic failure.

6. Cryogenic Control Room monitoring for any type of cryogenic loss.

7. The visual properties of a major He release.

8. The location and number of warning systems both audible and visual that would be activated in the event a leak was detected by the Cryogenic Computer Control system.

Lastly, it is my opinion that the RHIC Hazard Classification of 0, identified in Table 4-A-2 of the RHIC SAD report, is appropriate for the facility with or without the ventilation system and ODH monitors operational. The fact that monitors are in place for an extremely well documented and essentially nonhazardous area does not establish a violation of an OSHA standard if the monitors are adjusted below 19.5%.

If you have any questions concerning this matter please contact me at your earliest convenience.

Very truly yours,

Richard H. Hayes DACFE
President